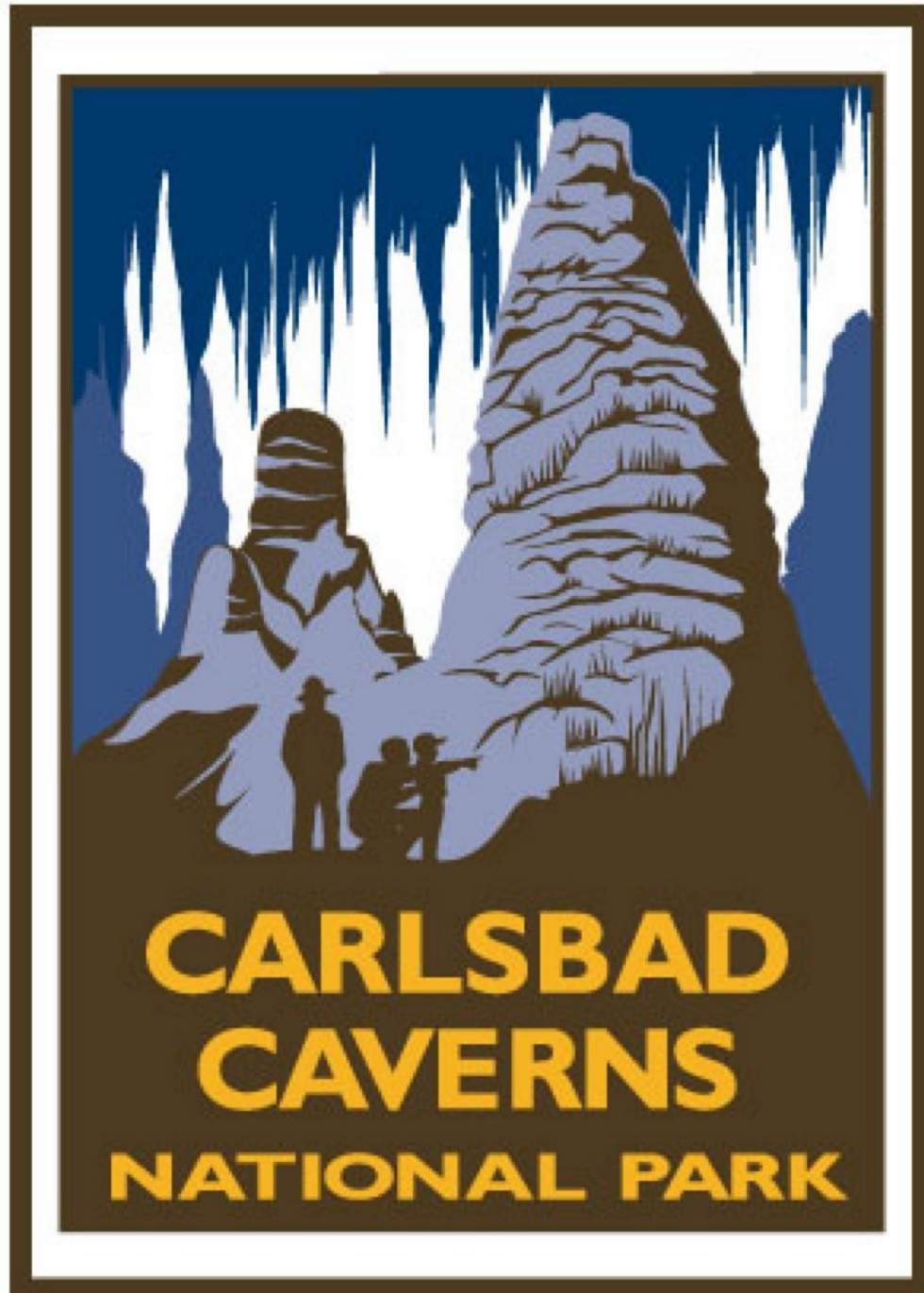


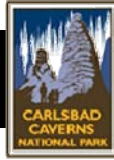
About Bats, Caves, & Deserts

A curriculum and activity guide for Carlsbad Caverns National Park



Elementary School



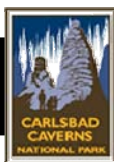


Section 2 – Just the Facts

The Significance of Carlsbad Caverns National Park

These statements explain why the park is important to our natural and cultural heritage:

- Carlsbad Caverns National Park, a world heritage site, contains large caves of world-class importance that have beautiful and diverse speleothems (cave formations); the Big Room in Carlsbad Cavern is the largest, most easily accessible chamber in North America.
- Lechuguilla Cave is the deepest limestone cave in the United States; it contains speleothems and microbes found nowhere else in the world.
- Carlsbad Caverns National Park preserves a portion of the Capitan Reef—one of the best preserved, exposed Permian-age fossil reefs in the world. The park's caves and canyons provide visitors with unique opportunities to view this reef from the inside.
- Capitan Reef has exceptional potential for additional cave discovery, exploration and research.
- The park contains one of the few protected portions of the northern Chihuahuan Desert ecosystem.
- Carlsbad Cavern has a world-famous colony of migratory Mexican free-tailed bats.
- Many species of plants and animals in the park are at the limits of their geographic distribution, including the northernmost and one of the largest colonies of migratory cave swallows in the United States.
- The park's cultural resources represent a long and varied continuums of human use starting in prehistoric times and illustrating many adaptations to the desert environment.
- Capitan Reef provides extraordinary scenic vistas, both from the top of the escarpment and from the rugged canyons below; the quality of these vistas depends on excellent air quality.



A Good Scientific Investigation

A good scientific investigation is not just one experiment. It is a long-term series of related experiments. A good investigation will be characterized by the following:

- It is as specific as possible.
- All factors are held constant except for the one factor being tested.
- It has a control. The control proves that the factor being tested actually caused the result being observed. It is a basis for comparison.
- It is extensive, continuing for a period of time and testing a large population.
- The student doing the investigation records each phase of work in a journal. The journal includes the thought processes the student followed, the work that led up to his/her experiment, the investigative techniques that were used, the results of each test, the problems that were encountered, and the solutions to the problems. Charts are also included in the journal to help organize the data collected.
- Its results are measurable or countable.
- Its experiments are repeated several times and the results are averaged.
- Its results are compared to known data.
- Its results are presented in charts and graphs. A good graph is neatly drawn, is large enough to be clearly seen, uses color or texture to clearly show a difference among items being graphed together, has limited items to prevent confusion, includes a key to explain colors or symbols, has a title and tells a purpose, and has labels for each axis to indicate what they represent and what measuring units are used.

Any *science fair exhibit* should contain the following:

- problem
- purpose
- hypothesis
- data
- results
- conclusions
- materials
- variable
- procedures

The six steps to the *scientific method*:

- State the problem.

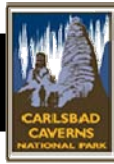
- Gather information.
- Formulate a hypothesis.
- Test the hypothesis, limiting the number of variables to one.
- Record and analyze any changes.
- State the conclusion.

When all is said and done, *scientists sometime disagree*. Even when utilizing the data collected from the same study, scientists may draw different conclusions. Yet, as non-scientists, we often feel we must accept whatever the experts write or say. But when they disagree, whom do we believe? How do we draw our own conclusions from the research? How do we know what is fact and what is really theory?

Below are a few questions that a non-scientist may attempt to answer to decide for himself/herself if something is *fact* or *theory*:

- Was the *idea* or *fact* tested through observation and experimentation?
- Is the *idea* or *fact* based on an assumption?
- Is the *idea* or *fact* consistent with other scientific laws; such as, the law of biogenesis, the law of heredity, the laws of logic, the laws of probability, the 1st law of thermodynamics; the 2nd law of thermodynamics?
- Was the *idea* or *fact* tested in such a manner that all things were considered - the actual structure of what was being tested and its chemical nature, etc.?
- Does circular reasoning or *scientific reasoning* support the *idea* or *fact*?
- Does the *idea* or *fact* sound sensible or does it conflict with what you are able to observe in nature?

If you read or hear something that just does not make sense to you, ***investigate***. It may be nonsense!



Fires at Carlsbad Caverns National Park: Foe or Friend?

A Healthy Force of Nature. The underground world is only half the story of Carlsbad Caverns. The park is located in the Chihuahuan Desert, a rich land where a wide diversity of plant and animal communities lives. Natural forces and processes constantly touch its landscape. Long droughts, torrential downpours, strong winds, lightning and wildfires all help shape the desert ecosystem.

Of all natural processes, fire is the least understood and accepted. Yet, it receives lots of attention because of its unmistakable signature—**smoke!**

Researchers believe large fires have occurred in the park about every 25 years. Fire is the most influential ecological disturbance of the park's plant and animal community. Fire has played a major role in shaping the grasslands, which once dominated the park landscape. Because fire releases nutrients into the soil, the fire cycle is needed to maintain nature's balance within the Chihuahuan Desert ecosystem. Without it, the soil would not be able to support its large number and variety of plant and animal communities.

During the first part of the 20th Century, many land managers thought fire was bad. A massive and very successful effort was made to teach fire prevention and to suppress wildland fire. Fires were extinguished as soon as they were spotted. The United States did a good job, in fact, too good of a job, extinguishing all fires. Although unplanned fires are often deadly, not all fires deserve a bad reputation.

Types of Fire. Today, all land management agencies make a clear distinction between types of fire. Wildfires are unwanted fires and are suppressed. Wildland fires, caused by nature's lightning, are closely monitored and allowed to burn within limits. Sometimes fire fighters plan, start and monitor fires for a healthy ecosystem. Today, these planned fires are called management- ignited fires and are allowed to burn within the limits spelled out in the fire plan for the area. Sometimes fires started by lightning or by management get out of control and become wildfires.

When fire managers plan a fire, they do their best to make sure the conditions are right to meet the goals of the plan. Managers consider the following:

- relative humidity
- temperature
- wind speed
- wind direction
- fuel moisture of the vegetation

Why Fire is Beneficial. Prescribed fire is an essential tool in our attempt to restore the park's out-of-balance ecosystem. Fires are planned for these reasons:

- **Fire reduces hazardous fuels that accumulate on the ground.** Forests and rangelands produce undesirable vegetation that ignites readily when dry. A destructive wildfire results when of large amounts of vegetation, much of it dead, is ignited.

- **Fire improves wildlife habitat.** Small fires cause woody vegetation to regenerate and re-sprout, resulting in palatable and nutritious food to wildlife. As thickets of dead and down trees are removed, new areas become accessible to wildlife.
- **Fire removes noxious and competitive weeds.** Harmful plants are either killed or injured by fire, depending upon how intense the fire and how long the plants are exposed to heat.
- **Fire is used to enhance landscapes.** Fire increases the number and visibility of flowering annuals and maintains open spaces. A diversity of vegetation also attracts a wider variety of animal life.
- **Fire releases nutrients into the soil.** It is an important agent in recycling nutrients found in living and dead plant materials. The growth potential for surviving new plant life improves. But without fire, nutrients may not be sufficiently released into the soil for new plant life to emerge.
- **Fire improves grazing.** Park rangers and forest rangers are not the only ones who use fire as a resource management tool. Ranchers use fire to improve grazing. When a fire is well planned and done correctly on ranch lands, the result is forage for cattle. The quality and quantity of grasses and forbs increase because dead materials are removed allowing new growth that is high in protein, phosphorous and calcium.

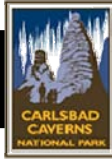
Fires Caused by Lightning. Lightning causes seventy six percent of the fires in Carlsbad Caverns National Park. These prairie and woodland fires are well documented in historic records from the late 19th Century. Tree ring studies have documented fire scars hundreds of years back. Most of these fires were relatively small, but have burned up to tens of thousands of acres.

Once a lightning fire is detected, park rangers assess the situation. Instead of rushing in and putting the fire out, they answer a few questions:

- Are conditions right for this fire to reduce fuels under the best conditions?
- Is there a threat to life, property, historical or cultural resources?
- Will the long term weather patterns help support the decision?

If these variables are all favorable, then park rangers begin strict monitoring procedure and allow the fire to burn. If any of these variables change, the fire is reclassified as a wildfire and is extinguished.

Fire Studies. Management-ignited prescribed fires are set at two or three locations each year at Carlsbad Caverns National Park. Along the park roadways you will notice a greater diversity of plant and animal life in the burned areas. Past research indicates that carefully managed fires increase the biological diversity of the park. Studies are underway on the effects of fire on plant colonization and distribution. The data will guide the park's prescribed fire program, which is aimed at restoring fire as a force in shaping the ecosystem.



The Bats of Carlsbad Caverns and Elsewhere

Please Protect Pest Controllers, Planters and Pollinators!

It's a bird; it's a plane; **it's a bat!** A bat is the only mammal that can fly. Its scientific name is Chiroptera (Ki-ROP-ter-ah), meaning *hand-wing*. I guess you can say a bat is handy to have hanging around. After all, bats are great for the ecosystem. Most eat tons and tons of harmful insects. Some species help plant rainforests, while others pollinate plants. The thousand species of bats are divided into two main groups—Megachiroptera (big hand-wing) and Microchiroptera (small hand-wing). We will call them megabats and microbats.

Eyes, Ears, Echoes and Eatables. Most bats are microbats. They live just about everywhere but the polar regions. That's because there isn't much food to munch on at the poles.

Microbats are known for their sound system-echolocation. They produce high-pitched sounds that humans cannot hear. These sounds bounce off objects. By listening to their echoes, these bats are able to judge size, distance and movement of everything in their path. Flaps of extra skin on their ears and noses help microbats catch their echoes.

The bats in the United States are mostly insectivores. Using echolocation, they identify moths, mosquitoes and various they flying insects. Bats usually catch prey in their mouths, but sometimes use the skin flap between their legs to catch insects.

Megabats have large eyes and long noses. Some megabats live in the tropics and eat fruits—frugivores. They swallow the fruit juices and spit out the flesh and seeds of the fruit. The fruit bat is believed to be nature's most important seed-dispersing animal. Plants that are dependent upon the fruit bats include bananas, breadfruit, carob avocados, dates, figs, peaches, cloves, mangos, cashew nuts, and agaves.

One megabat species echolocates. It makes a non-ultrasonic clicking sound that echoes off cave walls. Once the bat is outside its dark roost, it uses its eyes to look for food.

A few bats are carnivores. They eat meat-small mammals, frogs, other bats and fish. Fish eating bats are piscivores. They use echolocation to detect ripples on the water's surface made by fish.

Nectivores pollinate flowers as they feed on pollen and nectar. These bats have long tongues that can reach down into flowers and lap up nectar.

Less than one percent of bats feed on blood. These vampire bats are called sanguivores. They live in Mexico, Central America and South America. There are only three species of vampire bats. Two of the three species feed on the blood of birds, and the other species drinks the blood of mammals-mostly cattle.

If you are worried about a vampire bat sucking your blood, better keep your toes covered! That's right. A bat is more likely to suck the blood from your toes than from your neck.

But should you go through life worried about catching rabies? No, not from bats. Very few bats are rabid (far less than one percent), and therefore rabies transmission from bats to humans is extremely rare. On average, there is less than one human death per year from bat rabies, which

means that you have a far better chance of being hit by lightning. However, you should still take precautions: as with any other wild animal, avoid touching bats. Be sure that your cats and dogs receive their rabies shots; your own pets are more likely to carry rabies.

Sleep in Peace. Bats are nocturnal, flying in darkness searching for food. During the day, they sleep hanging upside down. Bats huddle closely together. Hundreds can hang out together in a single, square-foot space!

Only bats that live in temperate climates hibernate. Hibernation allows their body temperature to cool down. To conserve body fluids, bats hibernate in cool, damp places like caves. However, Mexican free-tailed bats at Carlsbad Caverns do not hibernate, they migrate south.

Hibernating bats should not be awakened before they are ready. The thirty-minute waking process causes bats to use much of their stored fat. If they cannot find food to replace their lost energy, they die.

Papa Bat, Mama Bat and Baby Bat. Papa bats and mama bats have baby bats—pups. Female bats of the same species gather in nursery colonies to give birth to and raise their pups. Colonies of bats often gather in caves.

Mexican free-tailed bats and most other bats have only one pup a year. Any more than two pups would weight down the mother, making flying very difficult.

Pups usually develop quickly, taking only six to nine weeks to become adult bats. They usually fly for the first time when they are three or four weeks old. By this time, they have permanent teeth, having already lost their milk teeth. Pups keep the Tooth Fairy busy!

Five hundred pups can roost in a one-square-foot area of a cave ceiling. These crowded conditions keep the babies warm. The warmer the pups, the faster they grow.

Mother bats leave their babies behind to find food. At sunrise, do you think a mother bat can return to the roost and locate her own pup, among thousands all huddled together? The answer is yes! We aren't positive HOW, but perhaps the nose knows. It is commonly thought that a mother bat identifies her own pup by recognizing its odor. Perhaps the mother also recognizes her pup's clicking sounds.

Yucky Guano! Some caves have million of bats living in them. At Carlsbad Caverns National Park research is being done to determine just how bats are living in the cave. Park rangers estimate that there are currently between three and five hundred thousand bats. All these bats translate into deep piles of guano!

Jim White, who explored Carlsbad Caverns a hundred years ago, estimated that a hundred-thousand tons of guano (bat droppings) were mined from the cave back in the early 20th Century. The guano was used to fertilize citrus groves in Southern California. Since becoming a National Park site, no guano has been mined.

Guano is more than a fertilizer. Many tiny creatures live and feed on the guano. Larger creatures eat the tiny creatures. It's part of a food-chain.

Who in their right mind would wade through tons of guano for the sake of education? Students might ask their teachers. Some Carlsbad teachers have braved the odor of bat guano. And for what? Just to go back to their classrooms and share first-hand knowledge of Bat Cave.

A Bad Rap! Bats don't deserve a bad reputation; they deserve a bat reputation. Bats don't get tangled in hair; they aren't flying mice; they aren't dirty; they aren't blind; and they aren't evil.

Bats have only a few natural enemies. Their predators include owls, hawks, and snakes. People are bats worst enemies. People ruin bat habitats when they clear forest and pollute. They kill hibernating bats by waking them. And some people even deliberately kill bats because they believe the bat myths.

However, bats have a fast growing number of friends. Many countries have laws to protect these beneficial creatures. Often cave entrances are covered with grating through which bats can go, but people cannot. Bat houses are becoming so popular throughout the world, that highway departments are building bridges that attract bats.

The City of Carlsbad, New Mexico is a bat friendly community. It is home to the International Bat Festival where bat education is fun for the whole family.

One way to remember WHY people today are protecting bats, is to think **P**. Bats are **p**est controllers, **p**lanters and **p**ollinators.

Batty Facts.

- Fifteen species of bats inhabit Carlsbad Caverns National Park.
- The bat is the symbol of happiness in many parts of the world.
- Some bats reach speeds of 60 miles (97 kilometers) per hour.
- Some bats live 32 years or longer, although most live fewer than 20 years.
- In the United States, rabid bats are rare; less than 1/2 of 1% carry rabies.
- Bats are the only major predators of night-flying insects.
- The smallest bat species weighs less than a penny and is about the size of a bumble bee.
- The largest bat species has a wing of 5'5" and weighs about 2 pounds.
- The total population of bats is estimated to be more than ten billion.
- Some bats reach an altitude of 10,000 feet (3,048 meters.)
- A bat's knees bend backwards.
- Most North American bats can be mailed with a 32¢ stamp.
- Baby bats' claws are so sharp they can hang on the imperfections of a light bulb.
- The 20 million Mexican free-tails from Bracken Cave in Texas eat the weight of 63 elephants in insects each night.

A Batty Poem.

Bats are mammals
like you and me
Some live in caves
and some live in trees.
Bats are nocturnal
they are active at night.
No bats are blind,
some have good sight.
They use echolocation
to find insects they eat.

They can fly at 60 miles per hour
and at 10,000 feet!

When the weather turns cold
and there's no food to eat
Some bats migrate or hibernate in a
deep sleep.

Some bats are pollinators
and some eat fruit.

Just look at their noses or ears,
they are adapted to suit.

So, don't be afraid
next time you see a bat.
They are part of nature
and belong just where they're at.

—Arizona Game and Fish Department, *WILD Kids*, Number 15

For More on Sonar Equipped Bats, Read On... Not all bats use echo ranging. Some nectar-sippers have sonar, but most large fruit bats and the “flying foxes” do not have sonar. They usually search for food by sight or smell. They have good vision, especially night vision. Although their eyes are specialized for night vision, they can see well during the day. Like other mammals with good night vision, bats are color blind.

With its larynx, a sonar-equipped bat makes short pulses of very high-frequency sound. With its nose and mouth, it may channel the wave pulses into a broad beam of sound. The bat uses its relatively large and extremely sensitive ears to detect sound. Its ear canal closes when pulses are produced and opens to receive the echo. Bat brains process sound well. Even when hundreds of thousands of same-species bats are flying in close quarters, like at Carlsbad Cavern, each bat is able to recognize and analyze its own echoes.

The resolution of bat sonar is truly astonishing. Bat sonar can detect wires that are nearly as wide as a human hair. Some species of bats can track a 3 mm fruit fly, and snatch it out of the air in 0.5 second.

Many animals can hear frequencies that are inaudible to people. Most people cannot hear sounds with frequencies higher than about 20,000 Hz. Cats can hear sounds up to about 25,000 Hz; dogs can hear sounds up to 35,000 Hz. But bats can hear sounds with frequencies between 12,000 Hz and 150,000 Hz!

For greater accuracy, most bats emit several frequencies at once, and many slide the frequencies up or down during the pulse. This technique is known as frequency modulation (FM). Because different frequencies are reflected in different ways by different materials, a bat can differentiate an insect from a leaf by sound alone. And you thought people were the only ones who stayed tuned to FM!

The bat evaluates frequency shifts in the echoes in order to determine the speed and direction of the target. One theory states that a bat is able to determine its target's location in relation to itself, by comparing the echo received by each ear. The bat also evaluates other characteristics of the target, such as its size, texture and orientation in space. Unwanted noise is filtered out of the echo by its ears and brain.

Bat sonar has three basic modes of operating—search mode, target mode and terminal mode.

When in cruising flight, a bat uses its sonar in a search mode emitting five to ten short pulses every second. Search mode allows a bat to detect obstacles or potential prey at a distance.

If a bat detects an object of interest, say a moth, it switches its sonar to the target mode. The bat focuses its sonar on a particular object, shortens the individual pulses and increases the number of pulses to between thirty and fifty per second. The bat then reads the echoes for information about the target's size and density, texture, speed, direction and altitude.

In the final tenth of a second, the bat switches its sonar to the terminal mode, increasing the pulse rate to as much as 200 per second. With great precision, the bat snatches its prey out of the air. The bat then returns its sonar to the search mode and continues its flight.

For Comments About Bats of New Mexico, Read On...

Western Pipistrelle—often the first bat out, sometimes even in daylight

Big Brown Bat—prefers human-made structures for roosting sights

Spotted Bat—black fur with three white spots and large pink ears, a late night flier

Pallid Bat—stalks scorpions, centipedes and small reptiles, nickname is “Rambo bat”

Townsend's Big Eared Bat—ears nearly as long as body

Allen's Big Eared Bat—audible calls

Mexican Free-Tailed Bat—largest concentrated groups of mammals in the world, can tolerate ammonia as high as 5000ppm

Pocketed Free-Tailed Bat—long, narrow wings

Big Free-Tailed Bat—likes moths, ants and crickets; communal in small groups of about 100

Western Mastiff Bat—largest bat in NM and USA; must free-fall at least 10 feet to begin flight

Southwest Myotis—daytime roosts still unknown

California Myotis—some hibernate, others do not

Long-Eared Myotis—hunts in tangled vegetation for insects

Little Brown Bat—common throughout USA

Western Small-Footed Myotis—may hibernate under rocks

Fringed Myotis—can rescue fallen pups

Cave Myotis—migratory, ears can touch tip of nose

Long-Legged Myotis—hunts in open country using one prominent harmonic tone

Yuma Myotis—desert hunter that lives close to water

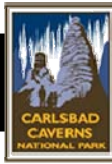
Western Red Bat—red fur, male more colorful than female

Eastern Red Bat—red fur

Hoary Bat—varied vocalizer, CF-FM both

Yellow Bat—fur a dusky yellow

Silver-haired Bat—frosted black fur; roosts and hibernates in freers, forages close to ground



The Geology of Carlsbad Caverns National Park

Coral Reef - Limestone Mountain - Limestone Cave - Decorated Cave

One Theory. None of us witnessed the formation of Carlsbad Cavern. And since time and conditions don't allow us to duplicate the process in a laboratory, we are left with theories based on puzzle pieces. One theory, simplistically stated is...

- A very long time ago, a shallow sea covered Carlsbad Cavern. Plants and animals lived and died in the sea. Their shells and skeletons piled on top of each other, making a reef. Over time, many layers piled up, squashing the shells and making the layers hard, compact and thick.
- The sea dried up causing the reef to be exposed to the air.
- Movements in the earth's crust pushed the reef upwards, forming a limestone mountain.
- Trees and other plants grew on the mountain, covering the old reef and causing cracks to develop in the limestone.
- Rainwater sank into the soil and went down through the plants' roots and finally down through the cracks in the limestone. On its way through the atmosphere and the soil, the water absorbed carbon dioxide. A weak acid was chemically formed when the water mixed with the carbon dioxide. The resulting carbonic acid dissolved the calcite in the limestone.
- At some point, large rocks in the cave ceiling fell. This opened up chambers, like the Cavern's Big Room—25 stories high and a third of a mile wide.
- As water seeped and dripped its way into the Cavern, beautiful formations decorated the cave.

Soluble Rock. The largest and vast majority of caves are formed in soluble rocks—those that can be dissolved by a weak, natural acid. Limestone, dolomite, gypsum and marble are soluble rocks. Carlsbad Cavern, Lechuguilla Cave, Slaughter Canyon Cave and Mammoth Cave are all solution caves.

Cave Formations. A cave formation is a speleothem. The word comes from two Greek words—*spelaiion* meaning cave and *thema* meaning deposit. Speleothems are mostly calcite, the same mineral that makes up limestone. When the water table lowers and air enters the cave conditions are right for the process of cave formations to begin. Slightly acidic water percolates through the limestone above the cave dissolving the calcite. When the water reaches the cave, calcite is redeposited.

Two factors that influence the growth rate of the cave formations:

- **Temperature**—The outside temperature affects the rate of decay of plants and animals. The higher the temperature, the faster the decay. As the decay rate increases, so does

the carbon dioxide in the soil. When high levels of carbon dioxide is present, the water flowing through the soil is more acidic.

- **Water**—The more rainfall, the faster the growth.

Two factors determine the shape of cave formations:

- **HOW THE WATER ENTERS**—Does the acidic water enter the cave by dripping, seeping or splashing?
- **WHETHER THE WATER STANDS OR FLOWS.**

Mineral content determines the color of a cave formation:

- Pure calcite is white, almost colorless.
- Iron and other minerals combine with calcite crystals to add red, orange and black.

What's in a Name? In the case of a speleothem, it's as good as a picture.

Soda Straw. A soda straw is hollow on the inside and has water dripping through it. Over time the inside clogs with calcite, causing the stalactite to grow larger.

Drapery. Water in a cave does not always drip. It may seep along a slanted ceiling, forming thin draperies that hang in folds. They are also known as curtains and ribbons.

Flowstone. Flowstone is a cave formation that looks like a flowing stone waterfall. It forms when water seeps down cave walls, over rocks and onto the floor.

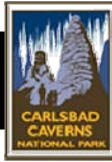
Shelfstone. A flat shelf of stone can form around the edges of cave pools and around stalagmites in a cave pool. Even if a pool dries up, the shelfstone remains.

Cave Pearls. Cave pearls are stone balls and can be as large as ping-pong balls. A pearl forms around grains of sand. Layers of calcite are added to the grain over time. Dripping water keeps the pearl moving round and round in the pool.

Popcorn. Popcorn is a cluster of calcite balls that build upon the walls of a flooded cave.

Helictites. A helictite is similar to a soda straw, except it curls and twists in every direction, even against gravity. No one is certain how helictites forms.

Totem Poles. A totem pole is as skinny as the stalactite above it. However, some are taller than skyscrapers and bigger than a giant redwood.



Types of Caves

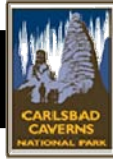
Cave and cavern are different words for the same thing. Caves are underground cavities formed by nature. Mines are manmade. There are more than 40,000 known caves in the United States; 88 have been discovered thus far in Carlsbad Caverns National Park.

Caves harbor rare animal life, fragile mineral formations and irreplaceable archaeological objects. That's why most of Carlsbad Caverns National Park's caves are **wild caves**. Only explorers who have special permits may enter them. **Show caves**, such as Carlsbad Cavern, are open to the public. They may have lights, stairs, railings and benches.

With 355 miles of passageways, Mammoth Cave in Kentucky is the **world's longest cave**. Lechuguilla Cave in Carlsbad Caverns National Park is the **deepest limestone cave** in the United States, thus far with more than 100 miles of surveyed passageways. The **world's deepest cave** is Jean Bernard Cave in France at 5,256 feet deep. The **world's largest cave chamber** is Sarawak Cavern in Sarawak, Borneo. The chamber is 2,300 feet long. The **largest room in North America** is Carlsbad Cavern's Big Room.

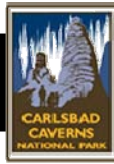
Caves are formed in various ways...

- **Solutional caves** are formed by weak, natural acid dissolving soluble rocks such as limestone, dolomite, gypsum and marble. Carlsbad Cavern is a solutional cave.
- **Lava tubes** form during the cooling of lava flows. First, a crust forms on the lava as it begins to cool. A break in this crust allows some of the molten lava to flow through the crack leaving long, tunnel-like passages.
- **Sea caves** form from wave action. The waves force water into the cracks in rock, breaking off the rock.
- **Wind caves** form from wind erosion on cliffs or hills. They are almost always small caves that seldom penetrate into total darkness.
- **Talus caves** form from huge rocks that have fallen from cliffs.
- **Glacier caves** form by melting waters moving through glaciers.
- **Soil caves** form when flash floods move through the soils and transport earth with them. They are found in desert areas.
- **Tectonic caves** form by the action of earthquakes.



Safe Cave Exploration

- Never go alone. Always go with at least two friends.
- Tell someone where your group will be caving and when you are going and when you are returning.
- Each caver should carry at least three sources of light.
- As a reserve, carry a waterproof packet of matches and candle.
- Remain in one spot if you become lost or your light fails.
- Wear heavy-duty clothing, high boots, kneepads and a hard hat are essential.
- Carry water.
- Carry a first aid kit.
- Carry tools for repairing lights.
- Carry a space blanket.
- Carry a compass, watch, note pad, pencil for recording your route.
- Only enter caves that you are prepared to enter. Proper training and equipment are need to enter caves with rugged, vertical or steep topography.
- Never trust equipment left in a cave.
- Never cave when you are ill, under medication or under the influence of drugs and/or alcohol.
- Obtain permission from the cave owner before entering.
- Leave the cave as you found it.
- Do not collect souvenirs! If you find an artifact, leave it where you find it. Report your finding.



The Wildlife of Carlsbad Caverns National Park

Members of the animal kingdom are classified according to body structure. The two general groups of animals are vertebrates (animals with backbones) and invertebrates (animals without backbones.) Vertebrates, making up less than one tenth of the entire animal population, include: birds, mammals, reptiles, amphibians and fish. The majority of animals are invertebrates. Invertebrates are divided into three general group—those with jointed feet, those with unusual bodies and those with one-celled bodies.

Carlsbad Caverns National Park has a large diversity of animals, both vertebrates and invertebrates. Because the park is part of the National Park System, its wildlife is protected. Annually, the park participates in the National American Ornithological Union Christmas Bird Count and has many cooperators involved in ongoing studies of bats, birds, mammals and reptiles.

In order to better understand and interpret the variety of wildlife, the park produces a monthly wildlife observation list, which is retained on file. All park employees, cooperating association employees and park visitors are encouraged to contribute to the list. Your group is welcome to submit completed Natural History Field Observation cards to the Surface Natural Resource Office. Cards are available at the visitor center.

Native Species.

Cave Species. Most insects, such as cave crickets, are found near sources of light and food-near bat roosts or along visitor use trails. There is little or no food to support larger animal species. The cave does not have running streams to provide a home for fish or amphibians.

Microorganisms. For thousands of years, microscopic bacteria and fungi have thrived in stable, dark cave environments. In Lechuguilla Cave, over 1,000 strains of microbes from the pools, soils, speleothems, corrosion residues and sulfur deposits have been isolated. On-going research is looking into potential medical application of knowledge gained by studying the microbes.

Bats. A large colony of about 500,000 Mexican free-tailed bats live in Carlsbad Caverns for seven months a year. They use the dry, dome-shaped room of the cave for roosting, birthing and nursing young. Migratory, they leave the park in the early fall and return from Mexico in the spring. In addition to the Mexican free-tailed bat, 14 other bat species live in the park, and two extinct species may have inhabited the park's caves in earlier times. The fringed Myotis and the California Myotis are common, along with Townsend's big-eared bat and Western pipistrel. Like the Mexican free-tailed bats, most of the other bats are seasonal residents.

Cave Swallows. Since the mid-1960s cave swallows have been roosting in mud nests in the twilight area just inside the entrance of Carlsbad Cavern. The Carlsbad Cavern nesting group is one of the largest populations in the United States and is apparently at the northern limit of its range. Visitors often mistake these birds for bats, as they circle near the cave entrance. A local school teacher, Steve West, has voluntarily banded,

weighted, sexed, aged and released more than 10,000 cave swallows. In 1999, local students will enter the data into a database and analyze it.

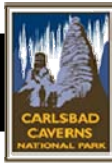
Surface Species. The park's surface wildlife species includes 331 species of birds, 64 species of mammals and 44 reptile and amphibian species.

Mule deer are plentiful. Large mammal predators include coyote, mountain lion and gray fox. Other mammals include elk, squirrels, bats, porcupines, ringtail, raccoons, badgers, rabbits, skunks, weasels and mice.

Bird species include hawks, ospreys, kites, vultures, falcons, owls, quail, nighthawks, ring-tailed pheasants, wild turkeys and bobwhites. Other birds that are sometimes found in the Rattlesnake Springs unit of the park include grebes, herons, ibis, swans, geese, wading and diving ducks, sandpipers, woodpeckers, flycatchers, swallows, warblers, vireos and hummingbirds. Rattlesnake Springs is recognized as one of the outstanding birdwatching sites in the New Mexico/West Texas region. More than 300 species have been observed. It is the only nesting site in New Mexico for the eastern bluebird. An estimated 90% of New Mexico's population of Bell's vireo nests are at the site.

Also found in the riparian habitat at Rattlesnake Springs are reptiles, amphibians and several fish species. Rattlesnake Springs provides habitat for some species found nowhere else in the United States, for example, the Texas emperor butterfly.

Non-Native Species. Barbary sheep are highly adaptable in their food selection and are able to survive in almost any rugged terrain. The Barbary sheep at Carlsbad Caverns compete with native mule deer and bighorn sheep.



Amphibians and Reptiles

Reptiles. The scientific name for reptile is Reptilia, which means to creep. Snakes lizards, turtles and crocodiles are reptiles. Lizards and snakes are the largest group of reptiles, with nearly 3,000 species of each. At Carlsbad Caverns National Park both are common.

These cold-blooded vertebrates breathe with lungs throughout their lives. They have tough, dry skin that is covered by a protective layer of scales. Scales preserve body moisture enabling them to survive for long periods without water. They live on land and lay eggs. Many species molt several times a year.

Predators of reptiles include birds, mammals and other reptiles. They avoid their enemies by using coloration that blends in with their surroundings.

Amphibians. The scientific name for amphibian is Amphibia, which means both-lived. Frogs, toads, newts and salamanders are amphibians.

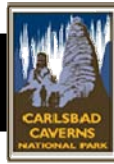
Amphibians develop through a process of metamorphosis—they undergo significant changes in form and structure during their life cycle. As larvae, they breathe with gills. After they reach adult-hood, they breathe with lungs. Their skin is smooth and moist. They lay soft-shelled eggs and spend their adult lives either in water or on land.

Some amphibians use coloration to protect themselves; others simply stay out of sight. Some produce poisons that irritate the mouths of their attackers. Their enemies include birds, snakes and mammals. Fish prey on their eggs and larvae.

Slitherers & Croakers.

Likenesses. Both are ectothermic. Most reptiles and amphibians shed their skins and many eat their old skin for protein. Most lay eggs and are able to change colors. All have an organ, which aids their sense of smell—Jacobson's organ.

Differences. Reptiles have dry skin covered with scales, while amphibians usually have moist, scaleless skins. Reptiles have claws on their feet, amphibians have none. They have different skeletal features and circulatory systems. Most amphibians lay soft, shell-less eggs in water. Reptiles usually lay shelled eggs on land.



The Cowbirds of Carlsbad Caverns National Park

Cowbirds do not moo, but they are associated with cows. Originally, they followed roaming bison herds in the great planes. They expanded their breeding range into improved habitats such as cleared forests, livestock grazing, agriculture and irrigation. Since the arrival of the Europeans to North America, they have not only increased their range, but also their population.

Brown-head cowbirds do not construct nests of their own, rather they lay their eggs in nests of other *host* species. Cowbirds formerly parasitized about 50 species. They now parasitize at least 220 species. This is a real problem because they decrease the nesting survival of the host species. Cowbird chicks usually require shorter incubation periods than their host species, are often larger, and seek food more aggressively from the host bird.

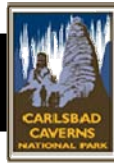
Declines of migratory songbird species, partially due to parasitism by cowbirds, have been documented throughout the Southwest. Desert riparian areas are of major concern as they are relatively rare, isolated, and provide important habitat for breeding birds. New Mexico has lost approximately 90% of its riparian habitat since European settlement. Over 50% percent of New Mexico's endangered bird species must depend on the remaining 10% of riparian habitat for breeding or foraging.

The riparian area at Rattlesnake Springs in Carlsbad Caverns National Park provides critical nesting habitat for many songbird species, including the New Mexico state endangered Bell's vireo. To determine the extent and effects of the cowbird problem at Rattlesnake Springs, park biologists conducted a program of nest monitoring in 1996-97. They found cowbird eggs in the nests of various bird species, including those of the Bell's vireo. When cowbird eggs were found in nests that were still being incubated by the host bird, biologists shook the cowbird eggs to prevent them from hatching.

The brood parasitism rates discovered during cowbird studies at six other parks in 1995 were low in comparison to rates at Rattlesnake Springs. At Rattlesnake Springs the rate is 33 percent. The highest parasitism rate of the six parks studied was at Point Reyes National Seashore – 10.7%.

Biologists continue to monitor nests and conduct point counts to determine the number of cowbirds that use the Rattlesnake Springs area. Cowbird eggs are shaken and replaced in the nests of state or federally endangered species (e.g., Bell's vireo and southwester willow fly-catcher) to increase breeding success of these sensitive birds. Cowbird eggs will not be added or removed from non-listed host species in order to determine the effects of brood parasitism on host success. Long-term mitigation measures, such as cowbird removal by trapping or shooting, possible habitat improvement for nesting birds and irrigation practices at Rattlesnake Springs will be critically reviewed and recommendations made for future management.

*Source: *Research in Carlsbad Caverns National Park: Scientific Exploration and Discovery*, 1997 Editor: Gary Vequist.



Mountain Lions at Carlsbad Caverns National Park

It has been blamed for crimes it never committed, described as having attributes it never possessed, and has been credited with feats it could not possibly accomplish. It has been considered a varmint, a livestock-killer, and a competitor for game animals. Homesteaders and ranchers shot the animal on sight. Many more were poisoned and tracked down with dogs. As a result of this indiscriminate killing, the cougar disappeared from the eastern United States and the prairies.

The cougar, like many predators, has gained a bad reputation, partly because it lives a secretive lifestyle shrouded in mystery. Unfortunately, the unknown cultivates fear and myth, and myths have perpetuated misunderstanding. Is the cougar the culprit legend has made it out to be, or is this animal a critical member of the Chihuahuan Desert ecosystem deserving of our protecting? Recently, a great deal of biological study has taken place and, as a result, the image of the cougar is slowly changing.

Cougars are in the cat family Felidae. They are large, unspotted cats: hence the name *Felis concolor*, or cat of one color. Colors vary from gray, brown, gold-tawn to russet, depending on where it lives. Underparts, chin and throat are dull white; the sides of the muzzle, back of the ears and tip of the tail are black.

One of the most outstanding characteristics of the cougar is the long heavy tail, which measures two-thirds the length of the body and head. Here, in the Chihuahuan desert, adult males average 125 to 160 pounds and adult females 90 to 110 pounds.

The genus *Felis*, or small cats, includes the cougar, lynx, bobcat, ocelot and the house cat; the cougar is the largest member of this genus. Cats in this genus purr but cannot roar.

As predators of large quarry, cougars have features that enable them to catch and kill prey. The teeth are large, especially the canines. Sharp claws are necessary for seizing and controlling prey. Eyes are important for predation. Cougar eyes are close together and face forward. This arrangement limits the total field of view but gives the cougar better depth perceptions, increases accuracy when attacking prey. Even the tongue is specially adapted with sharp protuberances that help to remove meat from bones.

Critics have charged that the National Park Service (NPS) areas are protecting large numbers of predators. The truth is that the nature of large predators requires a low density of the animals throughout their range. Many predators, including the cougar, need a lot of space to find sufficient food. In the Chihuahuan Desert, biologists estimate that cougar density is three to five animals per 100 square miles. For perspective, human density in New Mexico is about 1,200 people per 100 square miles. Biologists estimate that to maintain a genetically viable cougar population for the next 100 years, a minimum of 500 adults would be required. All the NPS areas in the state of New Mexico combined would not be large enough to maintain healthy cougar population.

Cougars have been blamed for preying on large numbers of domestic animals, particularly sheep. Unguarded sheep can be easy prey for cougars and significant economic losses may be incurred as a result of cougar predation. Although predation of livestock may occasionally occur, it is not typical of cougar hunting behavior. The cougar's major prey species is mule deer,

making up approximately 75% of their diet. Also, there is a need in young cougars to have items identified as food. Thus, the prey they are taught to kill by their mother becomes an important component in their adult diet. A female that has not learned to kill cattle or sheep will not teach her young to do so.

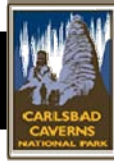
Another common misconception is that cougars devastate deer and elk populations. In a study conducted by Sweanor and Logan in the San Andres Wildlife Refuge, findings show that even with cougar predation, deer populations have been steadily increasing. They also found that deer populations fluctuate more due to environmental conditions such as drought rather than predation. Some studies even suggest that cougars may be critical to maintaining healthy deer populations. By keeping deer numbers in check, cougars reduce competition between members of the prey species and keep deer moving, which in turn avoids overbrowsing.

What happens when predators are removed from the ecosystem? This question is still being studied. With research comes understanding, and with understanding may come a desire to restore and protect these elusive and beautiful animals.

—by Park Ranger Lynn Carranza, *Felis concolor*, Spring 1998

During the mid-1980s, 22 mountain lions were radio-collared in and around Carlsbad Caverns National Park. Biologists estimated that an average of 58 mountain lions roamed the 400-square mile study area each year. Twice yearly, biologists travel the same trails keeping their eyes on the ground looking for signs-scat, tracks, scrapes and lion-killed deer. Signs indicate that then lion population is stable.

The State of New Mexico is devising a statewide plan for managing mountain lions. The data collected at Carlsbad Caverns and Guadalupe Mountains National Parks will help park managers to speak intelligently about the status and trends of the lion population in the Guadalupe Mountains.



The Rodents of Carlsbad Caverns National Park

The Forgotten Animal. The simple fact is that park visitors come to see the cave, and frequently, the bats. Sighting mule deer is an unexpected plus for most visitors; unless, of course, the deer they see run into their car. Rattlesnakes also get their share of attention from park visitors. You can be certain that people return home with tales about the cave, the bats, the mule deer, the snakes and even the furry tarantulas.

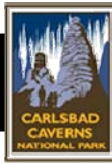
But has any visitor ever gone back home talking about the rodents of Carlsbad Caverns National Park? Not likely. Until recently, almost nothing was known about the most diverse group of mammals inhabiting the park. Most information on this group was based on a few museum specimens and a publication written almost seventy years ago.

Rodent Survey. In the early 1990s, the National Park Service funded a study to determine the kinds, distribution and relative abundance of rodents living within the park's boundaries. The survey found 27 rodent species including squirrels, pocket gophers, kangaroo rats, pocket mice, harvest mice, woodrats and porcupines. Six species were reported in the park for the first time. The results of the survey provided basic ecological data for making park management decisions and for designing accurate interpretive programs. The baseline information can be used for monitoring population trends. Studies will continue at the park because rodents are indicators of habitat quality in the park.

Focus: The Kangaroo Rat. Among the rodents of Carlsbad Caverns National Park is the tiny kangaroo rat. It is one of the few animals that never needs to drink water. It gets its moisture from the plants, insects and dry seeds. When a kangaroo rat finds food, it may stuff some of it into its cheek pouches, then carry the food to its burrow for storage.

All mammals, including rodents, produce water as they digest their food. While all mammals produce this water, only the kangaroo rat can survive on the tiny amount it produces. The kangaroo rat is the expert when it comes to using water efficiently.

* Source: *Research in Carlsbad Caverns National Park: Scientific Exploration and Discovery*, 1997, Gary Veqvist, Editor.



The Vegetation of Carlsbad Caverns National Park

The lower elevations of Carlsbad Caverns National Park are located in the Upper Chihuahuan Desert; upper elevations are a transition zone between desert and the Southern Rocky Mountains, making the park's flora very diverse and more characteristic of areas to the north, south and west.

Native Species. As part of the northern Chihuahuan Desert vegetation zone, the park consists mostly of shrub and grassland. The park has about 800 plant species. Desert shrub is found mainly at the lower elevations. Common plant species include sotol, creosote bush, redberry juniper, white-thorn acacia, prickly pear, algerita, desert willow, Mexican buckeye, toothed maple, lechuguilla, ocotillo, Torrey yucca, catclaw, and grasses.

Common in high elevations and on north-facing slopes are sotol, oak, mahogany, lechuguilla, New Mexico agave, catclaw mimosa and grasses. The highest elevations at the park's west end have a very unique flora - primarily a grassland or savanna with scattered pinyon pine, alligator and rocky mountain juniper, ponderosa pine, and other oaks. There are more flowering forbs in the higher elevations. Two distinct blooming periods occur: in the spring and late summer. The distinctive New Mexico agave and maguey plant can also be found at these high elevations.

Vegetation changes have occurred from trespass grazing and from fire in historic times. Most park boundaries have now been fenced, eliminating trespass grazing and allowing the return of more natural vegetation.

An indicator plant is a plant that is found only in a certain area. Indicator plants of the Chihuahuan Desert are lechuguilla, tarbush, sotol, and candelilla.

Non-Native Species. There is a dozen known nonnative plant species in the park. Common nonnative plant species in the park include Johnson grass, tree of heaven, common horehound and yellow star thistle. The common horehound and yellow star thistle might easily spread and displace native plants.

Within the Rattlesnake Springs unit of the park there is a historic district. The district's nonnative fruit trees and ornamental trees and shrubs are part of the area's history. Nonnative Russian olive trees and salt cedar trees are present at Rattlesnake Springs both within and outside the historic district. In most circumstances, Nonnative plants in the park are inventoried and some pulled by hand.

Survival Tricks.

Transpiration Tricks. Desert plants use the sun's energy to convert carbon dioxide and water into sugar. During this process of photosynthesis, small pores (stomata) on a plant's leaves and stems open to absorb carbon dioxide from the air and release oxygen. Each time the stomata opens, water is lost. This water-loss process is known as transpiration.

If desert plants were to lose a large amount of water through transpiration, they would be unable to replace the water easily and would die. Luckily, they have some water-saving tricks:

- smaller, fewer and deeper stomata
- waxy coverings
- open stomata at night to carry out transpiration at night
- little leaves or no leaves at all to lessen the surface area exposed to the sun and wind
- roll leaves to hide from the sun
- drop leaves during droughts

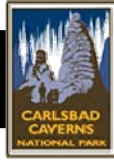
Sucking It Up Tricks. Desert plants get as much water as possible. Some have very deep taproots; some have huge, tangled networks of shallow roots that spread out in all directions; and many have both a deep taproot and a network of shallow roots.

Shrinking and Swelling Trick. Many desert plants store the water that their roots soak up and then use it during periods of no rain. Succulent plants store the water in their fleshy leaves and stems. Some succulents have folds that allow them to swell with water during wet periods.

Hairs and Spines Tricks. Hairs and spines reduce moisture loss by breaking the wind. They also cast shadows on desert plants helping them hide from the sun. Some hairs and spines are shiny and reflect the sunrays. They also protect the plant against hungry animals.

Chemical Trick. Chemicals of some plants, keep other plants from growing nearby, thus reducing competition for the scarce water supply.

Seed Tricks. Some seeds wait out dry spells in a dormant state—sometimes for decades. Some seeds are covered with natural chemicals, called inhibitors. The chemical keeps the seeds from germinating until enough rain falls.



The Backcountry of Carlsbad Caverns National Park

Carlsbad Caverns is best known for its caves, but there is another part of the park that few visitors ever see—33,125 acres of wilderness. With a little extra time and preparation, the opportunity exists to explore beyond what the average person will experience.

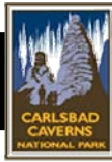
This is desert country, full of deep rugged canyons and tree-lined mesas far from the stresses of civilization. One can hike in the backcountry for days and never encounter another person, hear traffic, or smell car exhaust. The 60 miles of hiking trails offer places for quiet contemplation as well as for friends to get away together.

Hiking in the desert is a challenging, yet rewarding, experience. To fully enjoy and appreciate your hike, remember that desert hiking requires time and preparation. Trails have been left undeveloped to preserve and enhance the wilderness experience. You may find yourself walking on narrow ledges or down steep, rocky draws. Carrying a topographic map and a compass is highly recommended. Climate is hot and dry in the summer, cold and dry in the winter. Over the year, temperatures may range from nearly zero to above one hundred degrees. Temperatures may change as much as fifty degrees in a twenty-four hour period. Summer rains may bring flash flooding in canyon bottoms.

If you are lucky, you will see wildlife—jackrabbit, ringtails, mule deer and roadrunners. Typical plants include sotol, agave, lechuguilla, juniper and desert grasses. Trees are found in the elevations. After a spring rain, you may see the desert come alive with flowers.

Be sure to wear sturdy and comfortable hiking boots and long pants to protect yourself from spiny desert plants.

Except for a few permanent seeps draining down canyon walls, water is scarce and unreliable in the backcountry. Be sure to bring at least one gallon per person, per day.



Rock Art

Rock art, as with any type of artifact, is a remnant of a culture. It may be prehistoric, historic or even modern. Pictures made on rock can be seen in many parts of the world. Only the person who created the rock art knew the meaning and why it was created. Experts, however, may attempt to understand by describing and classifying the rock art. But, even without exact meanings, we can all enjoy and learn from rock art. Native American people created rock art on the surface or in the mouth of caves at Carlsbad Caverns National Park. Throughout New Mexico and around the world, many people of many different cultures produced various kinds of rock art. **Rock art** is of two types—**petroglyphs** and **pictographs**.

Petroglyphs are carvings of symbols into rock. *Petro* means rock or stone, and *glyph* means a carving or marking. Pictures and designs were cut into or carved in relief on large rocks, rock faces of caves, sheer rock cliffs or other similar places, using several methods. One method of making petroglyphs was by pecking. This was often done by means of a direct blow with a hammerstone, a tool sometimes found in association with petroglyph archeological sites. This method did not provide precise control over the placement or size of the dent, and produced rough or uneven looking petroglyphs. Sometimes the designs were made up solely of evenly spaced holes which produces a “stippled” effect petroglyph. In other parts of the world are found percussion formed holes called *cupulas* which cover entire boulders, but are without an apparent overall design.

Chiseling is another method used to produce petroglyphs at Carlsbad Caverns National Park and other areas. Using two stone tools, one being used as a hammerstone and the other a chisel, the artist could produce carvings of much finer detail than those made by using a hammerstone alone.

A third method used in making petroglyphs is called incising. This consisted of rubbing, grinding, scratching or carving a picture or design into a rock face with either a sharpened bone or hard stone tool. In historic times, iron and steel tools were used to make incised petroglyphs throughout the Southwestern United States.

A fourth method, not common in the park, is drilling holes or marks into the rock.

Pictographs are rock paintings, usually found in more protected and concealed areas than petroglyphs, possibly because of their higher vulnerability to weathering. Pictographs are the most common type found at Carlsbad Caverns National Park. Colored rocks and minerals were powdered for pigments and produced reds, yellows, whites, blacks and even some greens and blues for use in paintings. The powders were mixed with a binding agent to help the paint adhere to a rock surface and to be fairly durable. Binding agents may have been plant juices, animal fats, raw bird eggs, water or even saliva.

Hematite, an iron oxide mineral, can make a red to reddish-brown paint. Limonite, another iron oxide mineral, often referred to as yellow ochre, produces many shades of yellow. A white pigment can be obtained by grinding white clay, chalk, gypsum, calcium carbonate or any other white mineral. A black paint can be obtained by using powdered charcoal. This source for pigment would have been readily available since fires were a very common occurrence for cooking, firing pottery or just to keep warm. Uncommon colors such as blue or green could be

produced by grinding up a mineral with a high copper content such as turquoise, malachite or azurite. Instead of a copper mineral, sometimes green paint was produced from an iron mineral called chlorite.

Rock art has been broken down into three classifications, for clarity. Drawings of any type of human figure are known as *anthropomorphic*, while animal figures are called *zoomorphics*. A symbol that cannot be classified into either of the other categories is simply called *geometric*.

Where does one find rock art? It is often found on vertical cliffs facing either south or east, but it can be also found in other localities such as inside of caves, in rock shelters, overhangs, near or around dwelling or storage sites, or on boulders. Areas of frequent travel such as trails have a large amount of rock art associated with them, as well as areas that are near water, or near unusual physical features.

Interpretation of rock art is very controversial. No one really knows what the symbols represent, but some commonly seen symbols or *glyphs*, seem to carry a meaning agreed upon by people of many different cultures. Spirals or concentric circles are believed to denote the sun. Others, however, suggest spirals represent water. The Hopi people believe that they show migration routes of their ancient ancestors. Handprints are said to be the signature of the artist who designed that specific rock art panel, but it has also been suggested that handprints denote a sacred area. There are numerous handprint sites found in many localities around the world. Interpretation is probably best when done by members of the cultural group which made the rock art. However, only the person who created the rock art really knew the meaning.

Common game animals such as big horn sheep or deer are often depicted in rock art and are thought to be ritual or hunting scenes. Many times hunters with weapons are shown along with the animals. Of course, rock art located in places other than the United States portray animals common to that particular place. In Australia, for example, kangaroos and echidnas are just as common in aboriginal rock art as bighorn sheep are here in the desert Southwest. Other types of animal life have also been represented in rock art, including bears, bison, cougars, coyotes, rodents, bats, scorpions, snakes, lizards, fish stingrays and birds. Even petroglyphs of animal pelts are sometimes seen!

Pottery and blanket designs are other common elements found in rock art. But human figures are probably the most widespread symbol. Men are represented in everything from hunters to possible *warriors* or ceremonial figures. Sometimes males are represented in very elaborate dress, and at other times, just as plain entities. A frequently seen male personage is a humpbacked flute player, often referred to as *Kokopelli*. He is believed to be a supernatural fertility being. He may also represent a trader carrying a backpack or a person afflicted with tuberculosis. Even though representations of men seem to be more numerous than those of women in rock art, occasionally one finds a glyph that is unmistakable a female. In Ancestral Puebloan rock art female figures can be identified by their distinctive hair style. Even today, some Pueblo women wear their hair arranged in two buns on either side of their head to signify they are of marriageable age. For some reason, plants are only seldom seen as rock art components. But occasionally, they too are represented. Growing corn plants are sometimes found in the *Four Corners* area of the Southwest.

Other things represented in rock art are astronomical in nature. Along with the commonly seen sun, moon and stars, sometimes more unusual sky events are recorded. Chinese records indicate that a star exploded within the constellation Taurus on July 4th 1054 A.D. This star, known today as the Crab Nebula Supernova, flared up to be ten times more massive than our sun, and it outshone everything in our galaxy for almost two months! Before dawn on the morning of July 5th, the crescent moon was approximately two degrees north of the supernova.

It is believed by some that this phenomenon was recorded by ancient man in rock art at Capitol Reef National Park in Utah, Chaco Canyon in north-central New Mexico, and many other sites in the *Four Corners* area. Many rock art specialists feel that crescents in conjunction with stars, spirals or sun symbols are representations of this unique sky event.

One of the major problems when studying rock art is how to date it. The ability to date a particular site absolutely is rare, but various methods provide means of *relative* dating. The amount of desert varnish, or patination as it is called, is an important means of determining the relative ages of petroglyphs made at different times on the same surface. Desert varnish or patina is the formation of a black or brown stain of manganese or iron oxides on rock surfaces. When a petroglyph is made, the design is pecked or scratched through this surface exposing the lighter unoxidized rock beneath the patinized surface. This lighter surface begins to oxidize as soon as it is exposed. The older the design is, the darker it becomes. If two or more designs on a surface were made at different times, the more recent one will be lighter in color. But because patina varies with the composition of the rock, exposure to sun and rain, and location, the degrees of patination alone is not an absolute guide for dating.

Superimposition is another way to determine the relative age of rock art. Designs were sometimes painted or pecked on top of older ones, and in some cases the figures of several different styles and time periods were made in the same spot. Figures on top are considered younger than those underneath. The association of house ruins with rock art is sometimes a very helpful dating method. Frequently, these archaeological sites can be placed in a given time frame by dating charcoal or other organic material with one of the many scientific methods of absolute dating or by the pottery types or other artifacts present. A useful approach of ordering the chronology of certain rock art styles has been the comparison of rock art figures with those on datable artifacts such as pottery, clay pipes or wall plaster in the ruins themselves.

Relative dates are sometimes provided by the content of the art itself. The first appearance of the bow as a hunting weapon, replacing the spear and the atl (spear thrower), is dated in Arizona as early as 200 A.D. It spread eastward across New Mexico, reaching West Texas between 600 and 1000 A.D. The appearance of the bow in rock art has been helpful in establishing the earliest possible date for these pictures. Conversely, rock art that displays atls or spear throwers are thought to predate those panels that show humans using bows and arrows.

The horse is another element that is useful for relative dating. The presence of this animal on rock art indicates beyond any doubt that one is dealing with art of the historical period. First brought to this continent by the Spaniards in the 16th Century, the horse was becoming popular among the Apaches of New Mexico as early as the first half of the 17th Century. Horses also began to appear in Navajo art in the 17th Century. Some Navajos and other Native Americans show the arrival of the European into the southwest as people in 17th Century. Spanish costumes are depicted on rock art panels. Rock art from even later periods symbolizes the technology of the times as it displays trains and Euro-American houses.

A very commonly asked question concerning rock art is, "Why was it drawn?" Since no one knows the answer for sure, this question only leads to more questions. Could they just be doodles? Do they tell a story? Were they for religious reasons? Or ceremonial? Are they recording historical or prehistoric happenings? Some people believe rock art is actually a form of writing, and each symbol can be read like hieroglyphics. Others say rock art is just that—art—something to be gazed upon and enjoyed. Only the artist who made the petroglyph or pictograph would know for sure. Whatever their meaning or why they were made, the rock

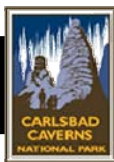
carvings and paintings by themselves are irreplaceable records and monuments to the artists who made them. They are a very unique and valuable tradition of human endeavor.

One thing that keeps us from ever finding the answers to rock art's mysteries is vandalism. Shooting bullets, scratching names and pictures on or near rock art, spraying paint, or defacing them in any way, forever destroys the chances of discovering their meaning. Even touching rock art or making rubbings of the symbols does irreversible damage to these priceless works of art! Presently, all cultural resources such as rock art and all other archaeological materials on federal lands are protected by the Antiquities Act of 1906, the Archaeological Resources Protection Act of 1979, and many other laws and regulations. The National Park Service, US Forest Service and Bureau of Land Management all work to enforce the laws which protect our rich heritage of cultural resources. Similar state and, often, local laws protect archeological resources on state and private lands.

So, please, allow others who follow to experience the same satisfaction in discovering rock art as you have. By conserving ancient rock art maybe someday more of their mysteries may be revealed.

As you have probably figured out by now, the study of rock art has much speculation and many educated guesses at best. Maybe no one will ever decipher all the petroglyphs and pictographs. Maybe no one will ever find out the reasons they were made. But if nothing else, rock art says, "I was here."

—Edited by David Kayser, Museum Technician



Jim White

In 1925, Jim White's friend, author Carl B. Livingston, wrote an article entitled *Through the Carlsbad Cavern with Jim White*, and said:

Jim White is not the explorer with the pith helmet, tight-legged pants and horn-rimmed glasses—but the genuine article of cowboy tradition. There is a difference between the “high-brow” explorer with money and prestige as speedsters to fame, and the prowess of the pioneer who blazes the way over a new horizons with just nothing save a step that is true and a light in his eye that knows no fear. There was no crowd of reporters to hang on Jim’s every word. Had he failed in his purpose, there would have been none of the soothing ointment of consolation that comes to explorers of position in the shape of “victorious defeat” when they do not succeed. Had Jim been killed, he would not have been a national martyr in the cause of science, but just a “durn” fool—he did succeed though and the hats are off to him.

White did not fail and was not killed. And, he was not a fool. Today, our hats are still off to Jim White. He first entered the cavern in 1898. Although he was not the cavern's discoverer, he explored it the most extensively. He privately guided tours from the early 1900s to 1923; he guided the 1923 General Land Office survey expedition; and, he guided the 1924 six-month National Geographic Society expedition. From 1923 through 1929, White guided visitors at Carlsbad Cave National Monument.

Jim White, with his equivalent of a third-grade education, spoke softly and infrequently. Livingston pointed out that:

Jim White does not talk much, except to a few, and not very often then. And I have it straight that what he says is not “windys” (sic) invented to entertain the dudes.

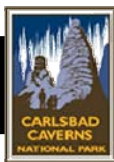
Willis T. Lee, 1924 NGS expedition leader, wrote in the National Geographic Society magazine that:

Like other guides before him, he has discovered that tourists appreciate hair-raising yarns more than hair-splitting distinctions. According to his own statement, our guide does not allow dull fact to interfere with a good story.

Eventually White guided a few people in the cavern who could show surface-bound people the wonders of the caverns—photographers. By 1923, cavern photos appeared in the *New York Times* and Carlsbad Cave National Monument was created.

White died in 1946 at the age of 64. In 1953, Congress appropriated money to erect a visitor center plaque honoring his accomplishments. Today, more than a hundred years after 16-year-old White ventured into the cavern, no single person's name is more synonymous with the caverns than that of Jim White!

—Park Historian Robert Hoff



Carlsbad Caverns National Park Area History, 1848-1998

By Robert Hoff, Park Historian

1848. February 2, the Treaty of Guadalupe Hidalgo is signed with Mexico after the Mexican War, transferring about 1.2 million-square miles of the Southwest, including Texas, to the United States.

1854. Captain John Pope of the Army Topographical Corps crosses the Guadalupe Mountains surveying possible routes for the railroad.

Dr. George Getz Shumard, a New Jersey-born military surgeon on the expedition, discovers Permian age fossils in the Guadalupe Mountains.

1858. The route of the Butterfield Overland Mail runs through the Guadalupe Mountains. A stage station is established at Pine Springs.

1866. Charles Goodnight and Oliver Loving begin driving cattle north along the Pecos River on the route that will become known as the Goodnight-Loving Trail. Loving is severely wounded in an Indian fight at Loving Bend on the Pecos River.

1867. John Simpson Chisum drives his first herd of cattle along the trail from Texas into New Mexico. He begins a ranch that soon extends from near Fort Sumner to the Black River.

1870. Seven Rivers (originally called Dogtown because of the prairie dog colonies there) is settled by the Herskill Jones family of Virginia. Situated where seven arroyos lead into the Pecos River, it will become an important trading post on the cattle trail from Texas.

Outlaw Billy the Kid frequently visits Seven Rivers. Billy the Kid will remain one of the most popular figures in Western history and a person who is looked at through the lens of mythology.

1875. John Chisum moves his cattle north from Black River. He continues to graze as far south as Seven Rivers.

1878. Dogtown is renamed Seven Rivers for the seven arroyos flowing into the Pecos at that point. Seven Rivers is just north of present day Carlsbad.

The Tenth Cavalry, an all Negro regiment (nicknamed the "Buffalo Soldiers") establishes a permanent camp at the old Pine Springs stage station in the Guadalupe Mountains. In October, Colonel Benjamin Grierson visits the camp and explores the Black River canyon.

1880. The Tenth Cavalry under Colonel Grierson crosses the Guadalupes and camps near the mouth of Black River on their way to the Fort Stanton reservation. There are several skirmishes with Apache parties supporting Victorio.

Dan Lucas begins ranching along the Black River on the property that is now Washington Ranch (Current-Argus, 8/19/31). This is the ranch which Jim White was working for when he first came across the cavern entrance.

1881. Henry Harrison arrives from Indiana and homesteads at Rattlesnake Springs. Cavalry patrols use his farm as a point of supply during the 1880s (Caverns, 39). In 1934, the National Park Service will acquire Rattlesnake Springs as a water source. From 1938 - 1942 Rattlesnake Springs will serve as a Civilian Conservation Corps camp. In 1963 Rattlesnake Springs will become a detached part of the National Park.

Colonel Nelson Miles and the Ninth Cavalry use Rattlesnake Springs as a rendezvous and supply camp in 1881-1883 (Current-Argus, 7/21/31).

1882. William C. Sublett finds gold nuggets in the Guadalupe Mountains eight to twelve miles from Pine Springs. Speculation is that the nuggets came either from a lost mine or from a cache of gold stolen from the Butterfield stage (Current-Argus, 6/4/30).

Jim White is born in Mason County, Texas on July 11. White will become the singularly most identified person with Carlsbad Caverns history.

1884. Charles B. and John Eddy form a livestock company with Amos Bissell to operate in southeastern New Mexico. One of their first ventures is the Halagueno Ranch which covers the area from Seven Rivers to La Huerta. (Halagueno is Spanish for promising and attractive.)

1885. The Valley Land Company owned by Dan Harroun holds the first water rights on the Pecos River.

1886. This is known as the year of the "big die." Drought causes the loss of about thirty-five percent of area cattle.

1887. Charles B. Eddy builds the Halagueno diversion ditch on the Pecos River three miles above the later site of Avalon Dam and incorporates the venture as the Pecos Valley Land and Ditch Company.

1888. Former sheriff Pat Garrett (Garrett shot and killed 22-year old Billy the Kid on July 14, 1881; 48-year-old Garrett will be assassinated on February 29, 1908 near Las Cruces, New Mexico) and promoter Charles Greene join with Charles Eddy to create a system of canals and flumes for diversion of water to their properties. Greene secures potential investors from the East including Robert W. Tansill, manufacturer of the Punch five cent cigar. Plans for a new town on the Pecos River are laid out by Eddy and his partners. A street and dam are named after Tansill and a street after Greene.

September 15, the town of Eddy is christened in champagne on the south bank of the Pecos River.

1889. February 25, Eddy County is created. The first county seat is at Seven Rivers.

James John Hagerman, miner and railroad builder, becomes a partner in the Pecos Irrigation Company.

October 6, the first school in Eddy opens on South Main with thirty-five pupils.

The first newspaper in Eddy, the Eddy Argus begins weekly publication with Richard Rule as editor.

Future caverns guano miner John B. Forehand establishes a ranch on the Black River (Current-Argus, 11/7/57).

1890. March, the Witt brothers complete construction of a wooden flume near Eddy. The purpose of the flume is to carry river water "across itself" for irrigation purposes.

The county seat changes from Seven Rivers to Eddy by a vote of 331 to 83.

The bridge over the Pecos River at Greene Street in Eddy is completed. So many Carlsbad servicemen suffer in the Bataan Death March during World War II that later the bridge is renamed the Bataan Bridge.

Avalon Dam and many of the canals leading from it are completed, financed by James J. Hagerman.

1891. Vaud, at the present site of Loving, is settled by fifty-four Swiss immigrant farmers.

Kirkwell, a station on the Pecos Valley Railway is also settled by Swiss farmers. Its name is changed to Malaga after a type of grape grown there.

January 10, the first railroad train arrives in Eddy on the newly completed line from Pecos, Texas, to the south.

A second newspaper, the Eddy Current, is founded by William Mullane.

Jim White's family settles at Lone Tree, a ranching community eight miles east of Eddy. Future cave explorer and guide Jim White is nine years old.

1892. Jim White goes to work for the X-X-X Ranch, belonging to John and Dan Lucas, about three miles from the cavern's natural entrance.

1893. The settlement of Otis is named for T. E. Otis, a director of the Santa Fe Railroad.

Heavy rains in July and August cause floods that wash away Avalon Dam, the wooden flume and the Greene Street bridge.

A school building is completed in Eddy at the present site of Edison School.

1894. By October, the railroad is complete from Eddy to Roswell.

1898. The first hospital and library are started in Eddy.

Main Corridor rock inscription inscribed "J White" and "1898," suggests that White may have entered the cavern for the first time in 1898.

1899. A post office is established at the present site of Artesia. It is named Stegman for a local land promoter whose wife, Sallie, is a niece of John Chisum. On their ranch is the first artesian well in the area.

May 23, Robert W. Tansill proposes changing the name of Eddy to Carlsbad after the mineral water spa in Czechoslovakia. This is approved by general city election.

1900. James W. Tulk secures water rights from the Queen Ranch to open a general store. In 1904, Tulk opens his store and post office establishing the town of Queen, 40 miles southwest of Carlsbad. Early population figures show about sixty inhabitants.

The Carlsbad Irrigation Project is reorganized and refinanced under the direction of Francis Tracy.

1903. Stegman changes its name to Artesia with the discovery of Artesian water in the area.

A cement flume, replacing the wooden one that washed away, is completed at Carlsbad. This structure requires 6,000 barrels of concrete.

June 16, Abijah Long establishes placer mining claim, 20 acres around natural entrance to caverns. Long heads up the first bat guano (droppings) mining company and sells out within a couple of years.

1903 – 1923. Main period of guano mining at the cavern. Thousands of tons of guano are mined during this period and is shipped mostly to California as a fertilizer. High shipping rates and intensive labor cause guano mining company ownership to change seven times. Jim White serves as a guano miner and foreman during this period and uses his free time to explore the cavern and to guide others into it.

About 1915, he takes in photographer Ray V. Davis whose photographs make the publicizing of the huge cavern easier than ever before. Soon the government sends a survey expedition (April - May 1923) and the National Geographic Society sponsors a day trip expedition which takes six months to complete.

1906. June 8, the Antiquities Act gives the President power to proclaim national monuments and also prohibits excavation or appropriation of antiquities on federal lands.

1911. February 11, Jim White's sister, Rosa, scratches her name on wall in the Appetite Hill area. In 1914 Rosa will marry Mr. Henry Samples, a friend of Jim's and an early National Park Service guide in the 1920s.

1912. January 6, New Mexico becomes a state, 62 years after becoming a territory. The same month 30-year old Jim White marries 18-year old Fannie Hill.

1916. August 25, Congress establishes the National Park Service. This is 44 years after the establishment of the first national park, Yellowstone, in 1872.

1917. April 6, U.S. proclaims war against Germany.

1918. First photographs in the Caverns' Scenic Rooms and Big Room are taken by Ray V. Davis. His photographs stimulates interest in the caverns. Davis photos will appear in 1923 New York Times. In 1927, Davis will start the Cavern Supply Company the concession company which provides food, souvenirs and other services to visitors.

1923. April 6 - May 8, Robert Holley, General Land Office (In 1947 the General Land Office and the U.S. Grazing Service will become the Bureau of Land Management.), surveys and maps cave, guided by Jim White and photographed by Ray Davis of Carlsbad. Recommends establishment as a national monument.

August 6, Major Richard Burges, prominent El Paso lawyer and long-time National Geographic Society member, begins campaign to make Caverns a national monument. He brings it to the attention of the National Geographic Society and to the United States Geological Survey.

Burges proposes construction of a tunnel from the plains into the Caverns to reduce difficulty of access. Tunnel idea is supported by NPS Director Mather until the \$30,000 estimated price tag makes it impracticable. Also making the non- selection of the tunnel option easier is that in 1925 the Carlsbad Chamber of Commerce donates the money to build a 200 step wooden stairway at the natural entrance.

September 19 - October 3, Dr. Willis T. Lee first explores caverns and recommends national monument status, joining General land Office Mineral Examiner Robert Holley's earlier recommendation based on his April - May 1923 expedition. Lee's article appears in January 1924 National Geographic magazine. Lee states in the article about Jim White:

The guide is the only source of such meager information as may be obtained. Far be it for me to cast aspersions on an estimable guide whose business it is to entertain his guests. Like other guides before him, he has discovered that tourists appreciate hair-raising yarns more than hair-splitting distinctions. According to his own statement, our guide does not allow dull fact to interfere with a good story.

October 25, President Calvin "Silent Cal" Coolidge speaks up and proclaims Carlsbad Caves National Monument.

1923 – 1927. W.F. McIlvain, a Carlsbad Chamber of Commerce President, serves as first custodian (superintendent), overseeing first trails, stairs and lights. He supervises Jim White, works with Willis T. Lee, coordinates with city officials and makes \$12.00 a year.

1924. March 20 - September 15, Dr. Willis T. Lee, sponsored by National Geographic Society and assisted by Jim White, extensively explores Caverns. Lee employs 21-year old daughter Elizabeth and 19-year old son Dana in the expedition. Dana keeps a detailed and interesting diary of the expedition. Within one week of the start of the expedition, a movie company arrives to shoot footage in the cavern.

(Willis T. Lee came to this area around the turn of the century on assignment with the United States Geological Survey to determine why some area dams were leaking from their reservoirs. He returned in 1923, again to investigate similar problems, and became interested in the cavern. Taking a period of leave from his United States Geological Survey in 1924, he organized and led the 1924 expedition. An inexhaustible worker, Lee promoted the cavern at every opportunity, writing and speaking about it, even on the radio.)

Lee, in April 1924, writes to Director Mather and suggests that when the tunnel is built into the Big Room that visitors be allowed to drive their cars through it and into the Big Room. Luckily, this idea was never put into effect.

Lee will leave in 1925, but will remain interested in the cavern's affairs, even discussing with NPS Director Mather in Washington, the reports from the caverns, including Jim White's projects in progress and requests for permission for various projects.

Lee will work on a Carlsbad Cave manuscript, never finishing due to his death in 1926 at age 61. Like White, Lee stands out as an energetic and devoted supporter of the caverns.

NPS Director Steven Mather visits in April and is photographed in a guano bucket with Willis T. Lee.

1925. Staircase from natural entrance to Bat Cave is installed, eliminating use of guano bucket to enter cave. Bucket material is donated by Carlsbad Chamber of Commerce through efforts of the first custodian (the 1920s term for Superintendent), W.F. McIlvain.

September, Willis T. Lee's second National Geographic article, detailing his second visit, is published.

1926. First trail established by NPS, dirt path and wooden stairways through Main Corridor, King's Palace, Queen's Chamber and 3/4 of Big Room. First electric lighting system via Main Corridor and King's Palace is installed. King's Palace has a telephone.

Willis T. Lee named the King's Palace "Shinav's Wigwam." His place names, with Native-American origins, were simply too difficult to pronounce and remember, and will be renamed.

1927. May 16, Col. (an honorary title) Thomas Boles enters on duty as first Superintendent and will serve until 1946. At retirement Boles will note that he spent approximately \$3 million in appropriated park funds during his tenure and collected in fees about \$3.5 million during the same period. Along with White and Lee, Boles deserves the recognition of being an extraordinary promoter of the cavern.

Boles travels as far away as California to promote the park (while on other park-related business). He speaks on a ham radio in Carlsbad to 2,000 listeners on the east coast. He promotes the building of roads and installation of elevators. Politically sensitive and aware, Boles never misses an opportunity to extend friendly and enthusiastic welcomes to visiting congressmen.

Boles promotes high quality and entertaining visitor services. His Rock of Ages ceremony gains fervent visitor support and is presented for 17 years in the Big Room at the cavern until national level forces deem it not suitable for a park program.

(Former Park Guide-Nurse and later Park Guide Supervisor (1943-1973) Olive "Johnny" Johnson said in a 1994 oral history interview that she had never met anyone who cared more about Carlsbad Caverns than the Arkansas-born, civil-engineer trained Tom Boles. Jim White, Jr. reported that his Dad and Boles didn't get off on the right foot together, but that they became friends. In 1946, the year that Boles was reassigned to Hot Springs National Park, he served as a pallbearer at Jim White's funeral in April.)

Boles will die in 1972 at the age of 90 and will be buried in a Carlsbad cemetery. Just months before his death he would travel to nearby Guadalupe Mountains National Park to attend its dedication.

Trail past Bottomless Pit opens. School for employees' children is established in park. The Cavern Supply Company is established. Fees to enter caves are \$2.00 per person.

June 23, first wedding ceremony is held in cave, performed at Rock of Ages.

1928. February, Charlie White (no relation to Jim White) homesteads 120 acres at Walnut Canyon, the future White's City.

May 16, Cavern Supply Company begins serving lunches in cave.

June, trail from top of Appetite Hill to Lunchroom opens.

November, electric lighting in Big Room is completed. Guides carry lanterns for emergencies only.

1929. July 27, First Rock of Ages ceremony is held. The presentation of this ceremony will continue until December 5, 1944, when it will cease due to broader agency directives. For years after its cancellation, visitors complain vehemently.

March, tunnel through Devil's Den is completed and opened. No longer is climb on a wooden staircase over Devil's Hump necessary.

May, first stone quarters is completed and occupied.

June 26, Jim White resigns due to failing health. White later changes his mind about resigning, but never re-enters the National Park Service. In 1936, White receives a permit to sell his life story pamphlet in the underground lunchroom.

June, Green Lake Room and King's Palace is connected by tunnel and trail constructed.

August, park personnel wear uniforms for first time.

September, first Bat Flight program is presented. This program continues to be very popular today.

November, nature trail opens to public.

1930. March, trail from Lower Cave Overlook to Top of the Cross opens, eliminating need to double back to the Totem Pole during tours.

February 18, Lake of the Clouds is discovered. At 1,037' beneath the visitor center, this is the lowest point in the Carlsbad Caverns.

February 20, Frank Ernest Nicholson with 14 assistants arrives to explore. According to Superintendent Boles, Nicholson's expedition stories were written for 55 newspapers and seem elaborate and unreal and his activities lacked anything of scientific value, but the park welcomes the associated publicity of his visit.

The Carlsbad Cave National Monument seeks to gain support for conversion to Carlsbad Caverns National Park.

April 16, tunnel at entrance is completed, and the staircase to Bat Cave area that had been used since 1925, is abandoned.

May 14, Congress designates Carlsbad Caverns National Park.

1931. August, elevator shaft is completed.

November, first elevator is installed.

1932. January, elevator goes into use. Interestingly, this \$100,000 elevator is installed during the Great Depression, but the cavern visitation is around 90,000 a year and the cavern is making money.

Lights are installed in Green Lake and Papoose Rooms, completing original electric lighting system.

June, first permanent female guides are employed.

July 3, tunnel between Papoose Room and King's Palace is dynamited, completed and opened, thereby connecting entire cave trail system.

1934. April 7, almost three thousand plus (2,871) people accompany the 10:30 a.m. guided tour, making this the largest single guided tour through the caverns to date.

1935. June 24, Rattlesnake Springs replaces Oak Springs as park water source.

1936. February 9, Jim White begins selling his book (ghostwritten by Frank Ernest Nicholson) in the cave. On his 1930 visit, Nicholson was a pseudo-explorer, would-be broadcaster and newspaper adventure writer who carefully blended facts and fantasy into exciting misinformation.

White's wife, Fanny, continues to sell Jim White's Own Story until her death in 1964.

1937. July, Tom Tucker discovers Slaughter Canyon Cave. Since the early 1970s, the National Park Service has provided tours of this primitive trail cave.

September 28, park receives the one-millionth visitor. This took 14 years to accomplish.

1938. February 16, discovery of Slaughter Canyon Cave (New Cave) is announced to public.

July 1, Civilian Conservation Corps (CCC) camp is established at Rattlesnake Springs, and will operate until April 1942. CCC boys build several buildings here and help repair rain storm-damaged Walnut Canyon road in September 1941.

First major renovation and improvement of the lighting is begun.

1939. Second group of employee housing is under construction (tri-plexes constructed of adobe and stuccoed) by CCC workers and will be completed in 1942.

January 25, Park Ranger Leslie Thompson falls down elevator shaft and manages to grab hold of cables at 125 feet into shaft; he suffers minor blistering to hands; he returns to work two days later. Thompson, a patrol ranger, will die of a heart attack in 1953 in his mid-fifties at Rattlesnake Springs.

February 10, President Franklin Roosevelt signs legislation adding approximately 39,000 acres to the park, including Slaughter Canyon. This occurs during the time F.D.R. still faced huge problems of poverty and unemployment at home and the rising spectre of Hitler's aggression in Europe.

Superintendent Boles accidentally met Eleanor Roosevelt in El Paso and invites her to visit the caverns, but her busy schedule does not permit.

Superintendent Boles invites famous people to the cavern. He shows the cavern to aviator Amelia Earhart, entertainer/philosopher Will Rogers, baseball player Ty Cobb, and others

June 2, Robert Ripley (Ripley's Believe It or Not) makes radio broadcast from Rock of Ages hill. Broadcast is carried by telephone cables to surface and carried nationwide on CBS radio. Boles, White and the New Mexico Governor John Miles took part.

1940. May 10, Sewage system and first flush toilets go into service in the Underground Lunchroom area. Replaces privy system installed in 1926. (This is only one of many examples of the incredible technology and hard work that has made the cave easily accessible to visitors.)

1941. December 8, U.S. proclaims war against Japan. Several NPS staff go off to fight. Many soldiers visit here. General visitation down due to gas rationing. A group of scientists try to develop idea of equipping sedated bats with incendiary bombs for dropping over enemy territory. Bats from caverns are "drafted" for the project. An accident resulting in burning government buildings puts the damper on further project development.

1943. April, shortcut under Iceberg Rock constructed.

1944. May, Superintendent's office moves from town of Carlsbad into park.

September, CCC buildings at Rattlesnake Spring are removed.

December 5, Rock of Ages ceremony discontinued. Becomes the most common visitor complaint for next ten years!

1945. September 8, Visitor fee for elevator use is eliminated.

1946. April 26, Jim White dies at age 64. U.S. Congress authorizes a plaque for the visitor center in 1953 to honor his achievements. (Although he did not discover the cavern, he was the

first to explore it extensively. White promoted it, guided it and built facilities at it. In 1998, on the 100th anniversary of White's probable first entry into the caverns, it is safe to say that no man's name is more synonymous with Carlsbad Caverns than Jim White's name. What Jim White, the mostly quiet and soft-spoken Texas native contributed to the history of the caverns, will continue to speak loudly for years.)

1948. January, first Park Ranger is permanently stationed at Rattlesnake Springs.

September, sloth bones found at Devil's Den.

1949. June 8, commercial electric power begins, replacing the park generator. Powerhouse is converted to vehicle garage, and its use as part of maintenance yard facilities will continue.

1950. March, motion picture "King Solomon's Mine" is filmed at Slaughter Canyon Cave (New Cave).

1951. Paving of cavern trail begins.

January, seating area at Rock of Ages hill is removed. Stairs from Whales Mouth to Devil's Den removed, is replaced by inclined trail.

March 14, construction employee Mr. Earl Rupe is killed by dynamite blast during construction in cave.

1952. August 19, Tex Helm takes the "Big Shot" of the Big Room using 2400 flashbulbs.

1953. Paving of existing trails is completed.

1954. January, Bat Cave seating area is completed.

March, Iceberg Rock seating area is completed.

Lighting system improvements and repairs, begun in 1952 completed.

July 8, second elevator shaft is completed. (Construction was begun in January 1954.)

1955. New elevators are installed and put into service. First fluorescent lights are installed in cavern.

Walk out tours are discontinued with advent of new elevators.

May, Top of the Cross seating area is completed.

1956. October, Carlsbad Caverns Natural History Association begins. (current name: Carlsbad Caverns Guadalupe Mountains Association)

March, stairway from Iceberg Rock to Green Lake Room is replaced by incline trail.

May, Putnam Cabin is constructed to facilitate overnight backcountry operations.

1957. August, camel bones are found in Slaughter Canyon Cave (New Cave).

September, all guano mining operations are halted at Slaughter Canyon Cave (New Cave); by the end of September, all mining equipment is removed from cave.

1958. January, jaguar bones are found at Slaughter Canyon Cave.

January 20, quit claim on the 40 acres over Bat Cave are filed, giving the NPS full control of the area.

1959. March, construction of the current Visitor Center is completed; old stone buildings near cave entrance are removed and tour operations are transferred to the visitor center.

Adjacent parking areas, originally constructed in 1940 as overflow are now used as primary parking, with the lower parking area designated as overflow and Bat Flight parking.

June, motion picture, Journey to the Center of the Earth, with Pat Boone and James Mason, is filmed in the King's Palace and Boneyard.

July, visitor center is formally dedicated.

1960. November, television show "Route 66" films an episode in the King's Palace.

1961. December 10, Project Gnome, a 5 kiloton nuclear weapon test, is detonated underground, 34 miles southeast of the caverns. (This test was to determine the feasibility of using nuclear power to generate electricity.)

1963. Bat Flight amphitheater at the natural entrance is constructed and placed into operation. First requested some 16 to 17 years earlier for seating area for Bat Flight viewers.

April 3, Civil Defense supplies are stored in the Underground Lunchroom area and the caverns are designated as a shelter for Roswell, Artesia, Hobbs, Carlsbad and adjacent areas. Plan unrealistically specifies that 25,000 people could use shelter at once.

May 13, Walt Disney visits the caverns and is personally guided by the park superintendent.

1966. June 26, Guadalupe Room, the 2nd largest room in the cavern, is discovered.

1967. June, self-guided trips through the Big Room are begun. Rangers are stationed at points (standing "beats") throughout the Big Room and interpret their section as visitors pass by. Tours are still guided through Main Corridor and Scenic Rooms.

1972. January 6, self-guided tours of entire cavern are initiated. Guided tours, which had been the primary method used to show visitors the caverns, come to an end.

1974. August, Telesonics radio interpretive system is placed into operation. Visitors begin carrying "players" for getting more information.

1975 – 1977. Caverns lighting system is replaced, a project long overdue.

1976. June 28 - July 4, during the Bicentennial Year, Tom Rohrer, assisted by Ron Kerbo, leads expedition into what is later named "Liberty Dome" over the Bottomless Pit (a 370' expanse top to bottom). Last time that mountain climbing "pitons" are permitted to be used in the caverns for the most part.

October 4, Park employee Tom "Boomer" Bemis explores a room with an opening so small that only he is the only park employee small enough to get into it. Room named "Bemis Chamber."

1977. January, current lighting and wiring system is completed. Emergency light system is installed, eliminating use of lanterns during power failures.

1978. November 10, under Public Law 95-625, 33,125 acres of Carlsbad Caverns National Park is designated as wilderness.

1979. July 10, four armed men enter the Underground Lunchroom area and “take over the cave,” securing hostages. Local newspaper editor volunteers to negotiate with perpetrators. Incident ends several hours later with arrest of the terrorists.

1980. May 17, Interior Secretary Cecil Andrus visits the park.

October 11, eighteen-year-old visitor is killed in accidental fall at the Natural Entrance.

1981. Ten other caves in the park open for recreational caving with permits subject to skills and experience of applicants.

March 16, NPS group, including Jimmy Sillas and Ron Kerbo, covers guano mining shafts for safety. Originally blasted in the early 1900s for the bat guano mining, the shafts, by the 1980s, were impacting on the nursery activities of the thousands of Mexican freetailed bats who annually arrived at the caverns.

July 9, Actor Ron Howard, formerly “Opie Taylor” of the Andy Griffith show and future Apollo 13 and Backdraft director, visits the Caverns.

1982. Project to remove utility wires and pipes from elevator shaft to separate utility shaft (from front of visitor center down to pump room) is completed.

October, Cave Specialist Ron Kerbo and Geologist Mike Queen use light cord, balsa wood and helium balloons to float cord to area 200' above Baby Hippo area, snagging a stalagmite. Later, both climb rope into area later named Balloon Ballroom Climb. Sixteen years have passed since the Guadalupe Room was discovered by searching into horizontal tunnels.

1983. June, wheelchair-bound visitor makes trip through the Natural Entrance and Main Corridor.

September 17, Interior Secretary James Watt visits park.

1984. June, a group of Colorado cavers receive permission to dig in the already disturbed floor of 90' deep with 200' of passageway in Lechuguilla Cave to investigate “blowing leads.” Six trips to dig out the loose dirt will occur between November 23, 1984 and May 25, 1986 when a small alcove is discovered. After taking steps to shore up the dug tunnel, the explorers hit pay dirt. By May 31, 1986, Lechuguilla will be surveyed at 3500' long and 703' deep.

1985. December 15, Cave Specialist Ron Kerbo, BLM employee Jim Goodbar, and Geologist Mike Queen again use helium balloons to float a cord to the ceiling area in the Big Room, 255' high, later named Spirit World. This is the same “technology” used three years earlier at the Ballroom Balcony Climb in the Main Corridor.

1986. Actor Pernell Roberts (Bonanza and Trapper John) visits the cavern.

August, actor Anson “Potsy” Williams (of “Happy Days” fame) visits the cavern.

September 5, Lechuguilla is surveyed at 7400' long and 927' deep.

October, NBC sent a cameraman/reporter on a “Spirit World” climb with Kerbo, Goodbar and others. Segment airs on the Tom Brokaw Evening News.

1987. June, Dr. Merlin Tuttle, president of Bat Conservation International, visits the park and says Carlsbad Caverns is likely the most important site in the world for public education about bats.

October 14, Lechuguilla is surveyed at 37,500' long and 1,207' deep.

1988. The Caverns Historic District and the Rattlesnake Springs Historic District is created. At the caverns architectural styles exist from the 1920s - 1930s, the 1940s and the 1960s.

February 26, Cave Specialist Ron Kerbo departs on a one month trip to the People's Republic of China as a member of the first American caving expedition to that country.

May 30, Lechuguilla is surveyed at 86,000' and 1,501' deep.

1989. Cave Specialist Ron Kerbo visits the Soviet Union August 22 - September 10 to reciprocate a Soviet cavers trip to America.

1991. March 31, Caver Emily Davis Mobley breaks her left leg about 1,000' down in Lechuguilla Cave. More than 150 rescuers team to bring her back to the surface in four days. Nation-wide press coverage results.

1992. January 4, Cristobal Colon, 20th generation descendent of Christopher Columbus, visits the park, arriving in a New Mexico State Police helicopter. Rangers give Mr. Colon a tour of the cavern.

1994. April, Lechuguilla surpasses 70 miles of known passageway.

December, a National Aerospace and Aeronautics Association (NASA) and National Geological Service team makes its 2nd five day trip into Lechuguilla Cave.

1995. December, Carlsbad Caverns National Park becomes a World Heritage Site.

1997. February, "The Gash," a 210' long cave, becomes the park's 85th cave.

1998. May, large elevators are replaced. New elevators have windows so that visitors may view the 75 story stone shaft as the elevator ascends and descends.

Employees prepare for October's 75th anniversary of the park's establishment, October 25, 1923.

Before summer, known passageways in Lechuguilla Cave is surveyed at 96 miles.

—Robert Hoff, Park Historian